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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re PATENT APPLICATION of:	
Roger NOËL	Confirmation No.: 7999
Application No.: 10/533,873	Group Art Unit: 3721
Filed: May 19, 2006	Examiner: Chukwurah, Nathaniel C.
FOR: ARRANGEMENT FOR CONTROLLING ROCK DRILLING	

APPEAL BRIEF

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Table of Contents

I. Real Party in Interest

The real party in interest is the assignee of record, SANDVIK MINING & CONSTRUCTION OY.

II. Related Appeals and Interferences

There are no related appeals or interferences which would have a bearing on the Board's decision in this appeal.

III. Status of Claims

Claims 1-17 are pending in the application. Claim 5 is allowed. Claims 9-13 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. Claims 1-4, 6-8 and 14-17 are rejected.

IV. Status of Amendments

On December 23, 2008, Applicants submitted an Amendment After Final with no amendments to the claims. In an Advisory Action dated February 6, 2009, the Examiner indicated the amendments will be entered upon filing a Notice of Appeal.

V. Summary of Claimed Subject Matter

The present invention relates to a method and apparatus for controlling rock drilling. As described on page 1 of the present application, beginning on line 21, when holes are drilled into

rock, the drilling conditions may vary. Typically, the operator controls operation of the machine based upon personal experience. When necessary, the operator may change the feed force and/or percussion power of the percussion device to suit a particular type of rock. In practice, the operator is only able to adjust one parameter and control its influence on the drilling process in seconds or tens of seconds. However, when the quality of rock changes rapidly, even a skilled operator will have difficulty adapting quickly enough to these changes.

The present invention solves this problem. For example, independent Claim 1 recites a method for controlling rock drilling wherein a percussion device 7, 25 belonging to a rock drill machine 1 delivers impact pulses to rock through a tool 9 (page 4, line 33- page 5, line 12; Figs. 1 and 2) and wherein the rock drill machine 1 is simultaneously pushed against the rock by means of a feed actuator 3, 33 (page 4, line 34- page 5, line 8; Figs. 1 and 2) the method, comprising feeding a pressure medium to the feed actuator 33 along at least one feed channel 37 (page 6, lines 19-22; Fig. 2); feeding the pressure medium to the percussion device 25 along at least one percussion pressure channel 24 (page 6, lines 4-5; Fig. 2); determining a penetration rate (page 7, lines 17-28; Fig. 2); adjusting at least a percussion pressure on the basis of the penetration rate (page 7, lines 17-28; Fig. 2), conveying at least one pressure medium flow supplied to or from the feed actuator 33 through at least one restrictor 46 (page 6, line 35- page 7, line 17; Fig. 2), sensing the pressure of the pressure medium before the restrictor 46 and after the restrictor 46 in order to determine the penetration rate (page 7, lines 1-28; Fig. 2), and adjusting the percussion pressure on the basis of the determined penetration rate (page 7, lines 1-28; Fig. 2).

Independent Claim 6 recites a rock drilling arrangement (Fig. 1) comprising a rock drill machine 1 including a percussion device 7, 25 arranged to generate impact pulses to a tool 9 to be connected to the rock drill machine 1 (page 4, line 33- page 5, line 12; Figs. 1 and 2), a feed beam 2 whereon the rock drill machine 1 has been arranged (page 4, lines 33-34; Fig. 1), a feed actuator 3, 33 enabling the rock drill machine 1 to be moved in the longitudinal direction of the feed beam 2 (page 4, lines 33-35; Figs. 1-2), a pressure medium system comprising: at least one pressure source 20 (page 5, lines 31-33; Fig. 2); at least one pressure medium channel 24 leading to the percussion device 25 (page 6, lines 4-5; Fig. 2); at least one feed channel 37 connected to the feed actuator 33 (page 6, lines 19-22; Fig. 2), and means 26 for adjusting a percussion pressure (page 6, lines 5-13; Fig. 2), and wherein at least one restrictor 46 is connected to at least one feed channel 37 of the feed actuator 33 (page 6, lines 19-22; Fig. 2), the arrangement comprises means for sensing 50 and 51 the pressure active in the feed channel 37 before the restrictor and after the restrictor (page 7, lines 7-11; Fig. 2), means 52 for determining the penetration rate on the basis of the sensed pressures before and after the restrictor and the pressure medium arrangement 20 is arranged to decrease the percussion pressure when the penetration rate increases (page 7, lines 11-28; Fig. 2). With respect to the determining means 52, one having ordinary skill in the art would understand determining means would include a computer system/software to execute the requisite calculations.

Independent Claim 14 recites a rock drilling arrangement (FIG. 1) comprising a rock drill machine 1 including a percussion device 7 arranged to generate impact pulses to a tool 9 to be connected to the rock drill machine 1 (page 4, lines 33- page 5, line 12; Fig. 2), a feed beam 2 whereon the rock drill machine 1 has been arranged (page 4, lines 33-34; Fig. 1), a feed actuator

3, 33 enabling the rock drill machine 1 to be moved in the longitudinal direction of the feed beam 2 (page 4, lines 33-35; Figs. 1 and 2), a pressure medium system comprising: at least one pressure source 20 (page 6, lines 4-5; Fig. 2); at least one pressure medium channel 24 leading to the percussion device 25 (page 6, lines 4-5; Fig. 2); at least one feed channel 37 connected to the feed actuator 33 (page 6, lines 19-22; Fig. 2), and means 26 for adjusting a percussion pressure (page 6, lines 5-13, Fig. 2), wherein the arrangement comprises at least one adjustment unit 34 for controlling the feed actuator 33 (Page 6, lines 14-16; Fig. 2), at least two relief valves 40, 42 arranged in series in load-sense channel 43 of the adjustment unit 34 (page 6, lines 26-34; Fig. 2), at least one restrictor 46 connected to the inlet feeding channel 37 of the feed actuator 33 (page 6, line 35- page 7, line 1), the arrangement comprises means 44 for controlling the pressure difference between the inlet feeding channel 37 of the feed actuator 33 and a reference pressure sensed in-between the mentioned two relief valves 40, 42 in the load-sense circuit 43 of the adjustment unit 34 of the feed actuator 33 (page 6, lines 28-34; Fig. 2), the reference pressure in-between the two relief-valves 40, 42 is sensed (page 6, lines 28-34; Fig. 2), the pressure after the restrictor 46 is sensed (page 7, lines 1-4; Fig. 2), and the arrangement comprises a control system 52 which is arranged to decrease the percussion pressure when the pressure difference between the above-mentioned sensed pressures decreases (page 6, line 28- page 7, line 28; Fig. 2). With respect to the control system 52, one having ordinary skill in the art would understand the control means would include a computer system/software to execute the requisite calculations.

Independent Claim 17 recites a rock drilling arrangement (Fig. 1) comprising a rock drill machine 1 including a percussion device 7 arranged to generate impact pulses to a tool 9 to be connected to the rock drill machine 1 (page 4, line 33- page 5, line 12; Fig. 2), a feed beam 2

whereon the rock drill machine 1 has been arranged (page 4, lines 33-34; Fig. 1), a feed actuator 3, 33 enabling the rock drill machine 1 to be moved in the longitudinal direction of the feed beam 2 (page 4, lines 33-35; Figs. 1 and 2), a pressure medium system comprising: at least one pressure source 20 (page 5, lines 31-33; Fig. 2), at least one pressure medium channel 24 leading to the percussion device 25 (page 6, lines 4-5; Fig. 2); at least one feed channel 7 connected to the feed actuator 33 (page 6, lines 19-22; Fig. 2); and means 26 for adjusting a percussion pressure (page 6, lines 5-13; Fig. 2), and wherein at least one restrictor 46 is connected to at least one feed channel 37 of the feed actuator 33 (page 7, lines 7-11; Fig. 2) along which the pressure medium returns from the feed actuator 33 the arrangement comprises means for sensing 50, 51 the pressure active in the feed channel 37 before the restrictor 46 and after the restrictor 46, means 52 for determining the penetration rate on the basis of the sensed pressures before the restrictor 46 and after the restrictor 46, and the pressure medium arrangement is arranged to decrease the percussion pressure when the penetration rate increases (page 6, line 35- page 7, line 28). With respect to the control means 52, one having ordinary skill in the art would understand the control means would include a computer system/software to execute the requisite calculations.

VI. Ground of Rejection to be Reviewed on Appeal

Claims 1-3, 6-8 and 14-17 stand rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 4,711,090 to *Hartiala et al.* in view of U.S. Patent Publication No. 20002,0179150 to *Balazy et al.* Claim 4 stands rejected under 35 U.S.C. §103(a) as being

unpatentable over *Hartiala et al.* in view of *Balazy et al.*, and further in view of U.S. Patent No. 5,121,802 to *Rajala et al.*

VII. Argument

A. Rejection Under 35 U.S.C. §103(a) Over *Hartiala et al.* in View of *Balazy et al.*

The present invention relates to a method and apparatus for controlling rock drilling. As described on page 1 of the present application, beginning on line 21, when holes are drilled into rock, the drilling conditions may vary. Typically, the operator controls operation of the machine based upon personal experience. When necessary, the operator may change the feed force and/or percussion power of the percussion device to suit a particular type of rock. In practice, the operator is only able to adjust one parameter and control its influence on the drilling process in seconds or tens of seconds. However, when the quality of rock changes rapidly, even a skilled operator will have difficulty adapting quickly enough to these changes.

The present invention solves this problem by providing a method and apparatus that (1) determines a penetration rate by (2) sensing the pressure of the pressure medium before and after a restrictor in the flow path of a feed actuator; and (3) adjusts the percussion pressure on the basis of the penetration rate.

The Examiner relies upon *Hartiala et al.* for disclosing the feature that the percussion pressure is adjusted on the basis of the penetration rate. However, *Hartiala et al.* does not support this conclusion. In the Office Action dated September 26, 2008, the Examiner alleges that *Hartiala et al.* discloses "determining maximum speed of the feed force", which the Examiner considered to be a penetration rate, and cites column 4, lines 42-43 of *Hartiala et al.*

However, the text relied upon by the Examiner in *Hartiala et al.* only discusses adjusting pressure medium supplied to a feed motor. Moreover, *Hartiala et al.* fails to disclose anything about adjusting the percussion pressure. This is simply because of the fact that *Hartiala et al.* relates to adjusting only feeding, as it is mentioned on column 2, lines 10-12: "The invention is based on the idea that the feed force of the feeder is affected by continuously adjusting the pressure in both pressure ports of the feeder...in this manner the feed force of the feeder can be influenced when the rotary resistance increases…".

Further, on page 2, lines 11 and 12, the Examiner states that *Hartiala et al.* discloses conveying at least one pressure medium flow supplied to or from the feed actuator (1) through at least one restrictor (19). This is not true, since in *Hartiala et al,.* the restrictor (19) is in a pressure line of a rotary motor (5), as it is clearly shown in Figures 2, 5 and 7 . Further, at column 5, lines 15 and 16, it is clearly stated that the throttle (19) is provided in the pipe of the rotary motor. Thus, there is no throttle in *Hartiala et al.* positioned in the pressure line of the feed actuator.

Further, the Examiner refers to column 4, lines 44-49 of *Hartiala et al.* and states that it is disclosed therein that percussion pressure is adjusted on the basis of the determined penetration rate. This is not true. At column 4, the embodiments shown in Figures 4a and 4b are described, wherein there is shown continuous thick lines along which pressure medium is led from a pump (9) to three separated circuits- namely to the feed device (1), to the rotary device (5), and to the percussion device (6). The valve (14) is a pressure regulating valve of the feed device (1) and has no influence on the pressure led to the percussion device (6).

The Examiner states that the valve (14) in the pressure line of the feed device (1) is for determining the penetration rate on the basis of the sensed pressures before and after the restrictor (19). However, in *Hartiala et al.* the penetration rate is not determined but instead the changes in the rotary resistance are determined for the control, see for example column 2, lines 13-15, lines 17-19, and lines 24 and 25, and further column 5, lines 15-30. The changes in the rotary resistance are determined and based on that information, the valve (14) is controlled. The valve (14) thus reacts only to the changes in the rotary resistance. Nowhere in *Hartiala et al.* is discussed about penetration rate and nowhere is suggested that the penetration rate is determined by arranging a throttle in the pressure line of the feed device.

Further, the Examiner states that the pressure medium arrangement of *Hartiala et al.* is arranged to decrease implicitly the percussion pressure when the penetration rate increases. Firstly, as discussed above, in *Hartiala et al.* the control actions are done on the basis of the determined rotation resistance and the penetration rate is not determined. Secondly, as discussed above, in *Hartiala et al.,* adjusting the percussion pressure does not belong to the disclosed control principles but instead only feed is adjusted on the basis of the determined rotation resistance. Moreover, the determined rotation resistance and the performed adjustment of the feed have no influence to the percussion pressure.

The Examiner states that *Hartiala et al.* implicitly shows the method of controlling percussion pressure. However, *Hartiala et al.* does not disclose any means for adjusting percussion <u>pressure</u>. At column 3, lines 59-63 of *Hartiala et al.*, it is said that the percussion element (6) is connected to the pump (9) by means of a <u>flow</u> direction control valve (28), and further, that the maximum <u>pressure in the circuit is limited</u> by means of a valve (25). The valve

(25) affects on the whole hydraulic system. Furthermore, the setting of the valve (25) is constant during operation and can only be set manually, as the drawing symbol in Figures 4, 4A and 4B show. Thus, in *Hartiala et al.* there is no means what so ever to control the <u>percussion pressure</u>. Accordingly, *Hartiala et al.* does not disclose the features of independent Claim 1.

Independent Claims 6 and 17 each recite a rock drilling arrangement, which include among other features, (1) at least one restrictor being connected to at least one feed channel of the feed actuator; (2) means for sensing the pressure active in the feed channel before the restrictor and after the restrictor; (3) means for determining the penetration rate on the basis of the sensed pressures before and after the restrictor; and (4) means for adjusting the percussion pressure.

Independent Claim 14 recites, among other features, (1) at least one adjustment unit for controlling the feed actuator; (2) at least one restrictor connected to the inlet feeding channel of the feed actuator; (3) means for controlling the pressure difference between the inlet feeding channel of the feed actuator and a reference pressure sensed inbetween the mentioned two relief valves in the load-sense circuit of the adjustment unit; and (4) a control system which is arranged to decrease the percussion pressure when the pressure difference between the sensed pressures decreases.

The Examiner states that in *Hartiala et al.* "at least one restrictor (19) is connected to at least one feed channel (13) of the feed actuator (1)." This is not true. As it is already discussed, *Hartiala et al.* teaches to arrange the restrictor (19) in the pressure line of the rotary motor (5). Therefore, there cannot be disclosure in *Hartiala et al.* of arranging the restrictor (19) in a feed channel of the feed actuator as defined in independent Claims 6, 14, and 17.

Moreover, as discussed above, *Hartiala* fails to disclose means for determining the penetration rate on the basis of the sensed pressures before and after the restrictor and/or a control system. As described above, one having ordinary skill in the art would understand that the control unit 52 includes a computer system/software to execute the requisite calculations. *Hartiala et al.* operates under completely different control principles, and as such, does not anticipate the "determining means" and/or "control system" of independent Claims 6, 14, and 17.

Balazy et al. does not make up for the foregoing deficiencies of *Hartiala et al.* *Balazy et al.* pertains to providing an accurate desired flow rate of process fluids, particularly gases (paragraphs [0003, 0004 and 0008]). In the final Office Action, the Examiner admits that the teaching of *Balazy et al.* relates to employing restrictor and sensor to control the fluid flow. It is true that *Balazy et al.* relates to a flow control system. However, in *Balazy et al.*, the aim is to have an accurate desired flow rate of process fluids, see paragraphs [0003], [0004] and [0008]. Contrary to the teaching of *Balazy et al.*, *Hartiala et al.* teaches to allow the pressure and flow differences across the restrictor because of the varying rotation resistance and it further teaches to utilize this allowed variation in flow for the control of the feeding direction.

The purpose in *Hartiala et al.* is not to achieve a predetermined accurate fluid flow over the restrictor, which is arranged in the pressure line of the rotation motor (6). Therefore, it would be illogical to combine the teachings of *Hartiala et al.* and *Balazy et al.* If for some reason the pressure flow in *Hartiala et al.* would be adjusted to be constant as taught in *Balazy et al.*, that would destroy the functionality of the control system of *Hartiala et al.* Accordingly, *Hartiala et al.* is not properly combinable with *Balazy et al.*

Further, the combination would still not determine the penetration rate and it does not control the impact pressure on the basis of the penetration rate. Accordingly, neither *Hartiala et al. et al.* nor *Balazy et al.*, in combination or alone, disclose the patentable features of independent Claims 1, 6, 14 and 17, and the claims depending therefrom.

B. Rejection Under 35 U.S.C. §103(a) Over *Hartiala et al.* in View of *Balazy et al.* and further in view of *Rajala et al.*

Claim 4 stands rejected under 35 U.S.C. §103(a) over *Hartiala et al.* in view of *Balazy et al.* and further in view of *Rajala et al.* Because Claim 4 is dependent upon Claim 1, Claim 4 is allowable for the same reasons as provided above with respect to independent Claim 1.

Accordingly, Applicants respectfully submit that the final rejection of the Examiner be reversed.

Respectfully Submitted,

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VIII. CLAIMS APPENDIX

The Appealed Claims

1. A method for controlling rock drilling

wherein a percussion device belonging to a rock drill machine delivers impact pulses to rock through a tool and wherein the rock drill machine is simultaneously pushed against the rock by means of a feed actuator the method, comprising:

feeding a pressure medium to the feed actuator along at least one feed channel;

feeding the pressure medium to the percussion device along at least one percussion pressure channel;

determining a penetration rate;

adjusting at least a percussion pressure on the basis of the penetration rate,

conveying at least one pressure medium flow supplied to or from the feed actuator through at least one restrictor,

sensing the pressure of the pressure medium before the restrictor and after the restrictor in order to determine the penetration rate, and

adjusting the percussion pressure on the basis of the determined penetration rate.

2. A method as claimed in claim 1, further comprising:

interpreting that the penetration rate has increased when, due to pressure drops, the pressure after the restrictor is decreased relative to a reference pressure before the restrictor, and

decreasing the percussion pressure when the penetration rate increases.

3. A method as claimed in claim 1, further comprising:

adjusting the percussion pressure in a predetermined manner with respect to the change of the penetration rate.

4. A method as claimed in claim 1, further comprising:

decreasing the percussion pressure and the feed pressure in a substantially constant ratio when the penetration rate increases.

6. A rock drilling arrangement comprising:

a rock drill machine including a percussion device arranged to generate impact pulses to a tool to be connected to the rock drill machine;

a feed beam whereon the rock drill machine has been arranged;

a feed actuator enabling the rock drill machine to be moved in the longitudinal direction of the feed beam;

a pressure medium system comprising: at least one pressure source; at least one pressure medium channel leading to the percussion device; at least one feed channel connected to the feed actuator; and means for adjusting a percussion pressure, and wherein

at least one restrictor is connected to at least one feed channel of the feed actuator,

the arrangement comprises means for sensing the pressure active in the feed channel before the restrictor and after the restrictor,

means for determining the penetration rate on the basis of the sensed pressures before and after the restrictor and

the pressure medium arrangement is arranged to decrease the percussion pressure when the penetration rate increases.

7. A rock drilling arrangement as claimed in claim 6, wherein

a first sensing channel is connected to a section of the feed channel residing before the restrictor in the direction of flow and a second sensing channel is connected to a section after the restrictor,

the first sensing channel is connected to a first pressure sensor and the second sensing channel is connected to a second pressure sensor,

the arrangement includes at least one control unit,

pressure data obtained from the first pressure sensor and pressure data obtained from the second pressure sensor m are arranged to be conveyed to the control unit,

the control unit is arranged to monitor a penetration rate on the basis of the pressure data obtained from the pressure sensors,

the control unit is provided with a control strategy for adjusting the percussion pressure in a predetermined manner with respect to the penetration rate;

and the arrangement includes at least one valve controlled by the control unit for adjusting the percussion pressure.

8. A rock drilling arrangement as claimed in claim 7, wherein

the control unit is provided with a control strategy for adjusting a feed pressure in a predetermined manner with respect to the penetration rate, and

the arrangement includes at least one valve controlled by the control unit for adjusting the feed pressure.

14. A rock drilling arrangement comprising:

a rock drill machine including a percussion device arranged to generate impact pulses to a tool to be connected to the rock drill machine;

a feed beam whereon the rock drill machine has been arranged;

a feed actuator enabling the rock drill machine to be moved in the longitudinal direction of the feed beam;

a pressure medium system comprising: at least one pressure source; at least one pressure medium channel leading to the percussion device; at least one feed channel connected to the feed actuator; and

means for adjusting a percussion pressure, wherein

the arrangement comprises at least one adjustment unit for controlling the feed actuator,

at least two relief valves arranged in series in load-sense channel of the adjustment unit,

at least one restrictor connected to the inlet feeding channel of the feed actuator,

the arrangement comprises means for controlling the pressure difference between the inlet feeding channel of the feed actuator and a reference pressure sensed in-between the mentioned two relief valves in the load-sense circuit of the adjustment unit of the feed actuator,

the reference pressure in-between the two relief-valves is sensed,

the pressure after the restrictor is sensed, and

the arrangement comprises a control system which is arranged to decrease the percussion pressure when the pressure difference between the above-mentioned sensed pressures decreases.

15. A rock drilling arrangement as claimed in claim 14, wherein the restrictor is adjustable.

16. A rock drilling arrangement as claimed in claim 14, wherein the restrictor has fixed settings.

17. A rock drilling arrangement comprising:

a rock drill machine including a percussion device arranged to generate impact pulses to a tool to be connected to the rock drill machine;

a feed beam whereon the rock drill machine has been arranged;

a feed actuator enabling the rock drill machine to be moved in the longitudinal direction of the feed beam;

a pressure medium system comprising: at least one pressure source; at least one pressure medium channel leading to the percussion device; at least one feed channel connected to the feed actuator; and means for adjusting a percussion pressure, and wherein

at least one restrictor is connected to at least one feed channel of the feed actuator along which the pressure medium returns from the feed actuator,

the arrangement comprises means for sensing the pressure active in the feed channel before the restrictor and after the restrictor,

means for determining the penetration rate on the basis of the sensed pressures before the restrictor and after the restrictor, and

the pressure medium arrangement is arranged to decrease the percussion pressure when the penetration rate increases.

IX. EVIDENCE APPENDIX- (NONE)

X. RELATED PROCEEDINGS APPENDIX – (NONE)